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Examining the structure of ideas of reference in clinical and community samples

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ABSTRACT

Aims: This study addresses the psychometric properties of a Spanish validation of the REF scale of ideas of reference (IRs) in detecting and following at-risk mental states and psychosis.
Methods: A total of 9447 participants were distributed in three groups: 676 patients with various diagnoses—154 with psychotic disorders, 6291 youths aged 11 to 20, and 2480 adult participants aged 21 to 84.
Results: Youths had higher scores than adults on IRs, observing a progressive decrease and stabilization in the twenties. Exploratory factor analysis provided a structure for the overall IRs score, with five first-order dimensions and one second-order dimension. Confirmatory factor analysis supported the structure with excellent fit. The REF scale was invariant across sex and samples. The internal consistency of the complete scale was excellent and acceptable across the five first-order factors. Strong relationships were found with the positive dimension of the community assessment of psychic experience-42, as well as with aberrant salience. Low and moderate relationships were found with public self-consciousness, anxiety, and depression. Youths and patients diagnosed with schizophrenia and other psychotic disorders had a high mean IRs frequency. Male sex, greater age (among the adults), and the "causal explanations", "Songs, newspapers, books" and "laughing and commenting" REF subscales showed predictive power in the diagnostic categories of schizophrenia and other psychotic disorders.
Conclusions: The results provide satisfactory that the REF scale could be used to study psychosis.

1. Introduction

Ideas of reference (IRs) are a form of self-referential processing [1] that concern the self and the distinction between self-generated and other-generated stimuli [2,3]. As IRs make inferences about the mental state and behavior of others [4,5], they could be considered a form of social cognition, which is a cognitive process that develops from adolescence onwards [6].

IRs, whether delusional or not, are frequent manifestations in various pathologies of the psychotic spectrum, as described in many classical studies [7–10]. However, since delusions are by nature self-referential, even when they do not involve delusional IRs, it may be that self-referential processing has been given insufficient attention as regards understanding the onset and maintenance of delusional activity in general and delusional IRs in particular [11]. From this point of view, IRs could be understood as one part of a process that leads to delusions, anomalous experiences that can culminate in the assignment of meaning as a positive symptom [12].

Clinical research often describes IRs as psychotic-like experiences (PLEs), which are studied in light of the broad psychotic phenotype, a psychometric continuum of interest for analyzing the risk and onset of psychosis [13]. Although PLEs are relatively frequent in the general population (about 8%), they have a low incidence of transition to threshold psychosis, which requires that the PLEs be persistent [14,15], that various preclinical expressions interact [16], and finally, loss of insight about the experience. Nonetheless, the concept of PLEs itself has often been criticized as not having any uniform definition, with imprecise boundaries between what is normal and pathological, as well as variable characteristics and clinical manifestation [17]. On the other hand, PLEs reliably increase the risk of mental health service use [18], even in cases that were originally considered false positives [19].

Many studies have suggested that IRs are of particular clinical importance among PLEs, and that their frequency and severity are critical to analyze the psychotic process [20]. For example, they are significant predictors of physical anhedonia [21], persecutory thinking, paranoia stability, distrust [22–24] and transition to psychosis in at-risk subjects [25].

IRs appear in all types of responses within the hierarchical structure of paranoia in the general population, they are the basis of persecutory

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ideas [26], and can even be the basis of grandiose thinking [27]. With regards to prodromal indicators, IRs are among the basic symptoms as unstable IRs, as it happens with the Bonn scale for the assessment of basic symptoms (BSABS [28]) or the adult versions and children and adolescent de la schizophrenia proneness instrument (SPI-A/SPI-CY [29,30]). IRs are considered prodromal among the criteria of ultra-high clinical risk [31], such as attenuated psychotic symptoms (stable IRs) and in Trait plus State Risk Factor (related to schizotypal disorder). IRs are also considered from the perspective of basic self-disturbance (e.g., examination of anomalous self-experience [32]; examination of anomalous world experience [33]), or, more generally, as a characteristic of schizotypy [34].

Lenzenweger, Bennett and Lilenfeld [35] developed the REF referential thinking scale to evaluate schizotypy, emphasizing that referential thinking is not necessarily linked to schizotypy and that it is not exclusively pathological. Later authors have attempted to differentiate so-called classical or simple IRs (they're looking at me, they're laughing at me, etc.) from guilt IRs [36]. Still others suggested IRs of communication (paralinguistic, non-verbal, mass media, inanimate objects) and of observation (related to paranoia [37]), and Cicero and Kerns [38] categorized IRs as either positive or negative. The REF scale [35] includes items on the ascription of causality to common coincidences [39], which is an attributional process related to the onset of delusional activity [40].

In summary, although research has tended to consider PLEs together, it may be of interest to analyze them separately [41]. IRs can be considered a PLE that is observable in the general population, and their relevance as a clinical sign probably depends on their intensity, or on the concern or distress they cause [42]. Furthermore, IRs may be responsible for the impaired reflective component of social cognition (social cue perception and mentalizing) seen in schizophrenia [4].

The REF scale is extensively used in research. The present study proposes a validation of the REF scale in Spanish, exploring its fit at different ages and in different diagnostic categories. As mentioned above, the scale presumes that IRs are prominent in adolescence, during which there is intense development of the self and of social information-processing [43]. To make IRs more useful for the study of psychometrics and the clinical risk of psychosis, their psychometric characteristics relevance as clinical indicators must be specified. In brief, IRs as a PLE can occur naturally in the general population, but their continuity over time may indicate the approach of psychotic activity [44].

The present study aimed to (1) elucidate the average prevalence of IRs by age and diagnostic group, (2) study the internal structure of the REF scale, (3) analyze the internal consistency of the scale and the evidence for convergent and divergent validity with other scales, and (4) study the predictive capacity of the REF subscales for detecting the psychometric risk of psychosis.

2. Methods

2.1. Participants

The final sample of this study comprised 9447 participants, after eliminating 659. The sample was distributed in three groups (see Table 1): the first consisted of youths from the general population without psychopathology and aged from 11 to 20 (healthy youth controls), the second comprised subjects from the general population without psychopathology and aged 21 to 84 (healthy adult controls), and the third was made up of patients with psychopathology aged 18 to 79. A total of 310 youths and 338 adults were eliminated from the sample because (1) they reported some psychopathology during the period of study (16%), (2) were taking psychopharmacological treatment (36.6%), (3) data were missing on the REF scale (28.7%), or (4) they did not answer all the questions (27%). Eleven patients were eliminated because their primary diagnosis comprised too few cases for analysis.

Table 1
Key characteristics of the sample distributed in three groups.

Characteristics	Healthy control youth ($n = 6291$)	Healthy control adults ($n = 2480$)	Patients ($n = 676$)
Mean age in years (*SD*)	15.54 (2.53)	31.56 (12.38)	34.63 (12.44)
Female %	58.7	63.2	59
Diagnosis (n)			
Depressive disorders			136
Adjustment disorders			64
Anxiety disorders			152
Somatoform disorders			44
Bipolar disorders			34
Schizophrenia and other psychotic disorders (SZOP) (3.89% residual stage)			154
Eating disorders			23
Others applicable to Axis 1			17
Personality disorders cluster "A"			11
Schizotypal personality disorder			5
Paranoid personality disorder			5
Schizoid personality disorder			1
Personality disorders cluster "B"			15
Personality disorders cluster "C"			8
Unspecified personality disorders			18

2.2. Procedure

The data were collected across several studies using various procedures. The youths took the tests in groups at their schools during class time. Of the adults, 44.9% were university students who filled out the tests in class, while the rest were found through snowball sampling. The patient sample was collected by incidental sampling of patients at one private psychology clinic and various public hospitals. The diagnoses were made by psychologists with over 20 years' clinical experience. To facilitate later statistical analysis, primary diagnoses were grouped together into categories, following the DSM-IV-TR [45].

All participants were informed of the research objectives and gave their written consent. Parents or guardians of the minors signed their consent. The study followed the precepts of the Declaration of Helsinki and was approved by the ethical committee.

2.3. Materials

Before the evaluation tests were administered, the participants completed a questionnaire about psychopathology, psychoactive drug prescription, sex, and age.

2.3.1. REF referential thinking scale [35]

This is a self-report that indicates whether the frequency of the subject's IRs suggests a clinical condition or is relatively normal within the general population. It consists of 34 items with "true/false" answer choices. The scale's authors contrived five factors: (1) laughing/commenting—the belief that others are laughing at the subject or commenting on the subject's behavior, (2) attention/appearance—the interpretation that other persons are paying special attention to the subject's appearance, (3) guilt/shame—related to the guilt or shame the subject feels, (4) songs, newspapers, and books—beliefs that the communications media, books or stories, contain messages for the subject, (5) reaction—changes or reactions of the subject. The total score of the REF scale is calculated as the sum of its items. The scale's authors found an internal consistency of 0.83 to 0.85 for the overall scale, as well as a strong relationship with measures evaluating perceptual aberration and magical ideation. Test-retest reliability was 0.86 after 4 weeks. Lezenweger's original article and the REF scale were translated into Spanish by a team comprising a native English speaker and one of the authors, both of whom were experts in its clinical contents. They

were then translated back into English and analyzed for unintended changes. The Spanish translation was then adjusted accordingly. Several clinicians reviewed the final version in Spanish (Appendix A in Supplementary Material). This version was applied to the university students and patients, with α-values of 0.83 and 0.91, respectively, and test-retest reliability values of 0.66 and 0.76 for students and patients [46].

2.3.2. Community assessment of psychic experiences-42 (CAPE-42) [47,48]

This self-report evaluates attenuated positive and negative psychotic experiences and depressive symptoms. It has 42 items with Likert-type answer choices from (1) "almost never" to (4) "almost always." The internal consistency of the Spanish validation was appropriate (α-value = 0.78 to 0.93) and was related to delusional ideation as well as to trait and state anxiety. The positive dimension was used in the present study. The α-value for the internal consistency of this dimension with the study sample was 0.75.

2.3.3. Aberrant salience inventory [49,50]

This scale consists of 29 items with "yes/no" answer choices. It evaluates the attribution of significance to stimuli that are usually irrelevant. The complete scale showed high internal consistency (α = 0.89) and evidence of concurrent validity with other measures of proneness to psychosis. In the present study, the scale had an α-value of 0.86 for the entire sample.

2.3.4. General health questionnaire (GHQ-28) [51,52]

This screening scale evaluates symptoms of anxiety, depression, somatization, and social dysfunction. It has adequate reliability (test–retest value = 0.90) and validity (sensitivity: 44%–100%, specificity: 74%–93%). In the present study, only the anxiety (α = 0.77) and depression (α = 0.79) subscales were used.

2.3.5. Revised self-consciousness scale [53,54]

This scale has 22 items with five answer choices from "not at all characteristic" to "very characteristic." It evaluates private and public self-consciousness and social anxiety. The Spanish version has adequate reliability (α-value for private self-consciousness = 0.92, α-value for public self-consciousness = 0.75, α-value for social anxiety = 0.81), and validity (content and construct) indicators. In the present study, the public self-consciousness subscale was used, with an α-value of 0.78 in the study sample.

2.4. Statistical analyses

The healthy population sample (youths and adults) was divided into age groups by decades. A one-way ANOVA of the total REF score was then performed on these age groups. Next, a one-way ANOVA of the average REF diagnostic categories was performed. The total sample (patients, youths and adults healthy) was divided at random into two groups. Exploratory factor analysis (EFA) was used with Sample 1 to find evidence of construct validity, and the structure found was subjected to confirmatory factor analysis (CFA) with Sample 2. Internal consistency was found with the ordinal α-value. The structure found was subjected to confirmatory factor analysis (CFA) by applying the "robust diagonally weighted least squares" method to the asymptotic covariance matrix. It was then compared with other models (null model, unidimensional model, and original model by Lenzenweger [35]). The models' fit was evaluated using the following goodness-of-fit criteria: Satorra-Bentler chi-square ($SB\text{-}\chi^2$), comparative fit index (CFI), nonnormed fit index (NNFI), incremental fit index (IFI), which had to be over 0.90 [55], root mean square error of approximation (RMSEA) and its 90% confidence interval and standardized root mean square residual (SRMR), which must be below 0.05 to be considered adequate, and between 0.05 and 0.08 to be considered acceptable [56]. In addition, Akaike's information criterion (AIC) were used to find the most parsimonious model. Multi-group confirmatory factor analyses (MGCFA) were conducted to test the invariance of the REF scale across samples and sex, following the steps recommended by Byrne [57], in which each new model is nested in the previous one and parameters are subjected to increasingly restrictive tests of equality. Firstly, the unconstrained baseline model was estimated separately for each group. A MGCFA was then carried out to evaluate configural invariance (M0), whereby the model parameters were estimated freely across groups. Next the model was tested to ensure that the constraining factor loadings were equivalent in the two groups (M1; factor loading invariance or metric invariance). The previous invariance of the factor loadings was then maintained, and all factor variances and covariances were constrained to ensure they were the same across groups (M2, structural invariance). The model fit was assessed in terms of ΔCFI and ΔRMSEA. Invariance was identified when (1) ΔCFI was ≤0.010 and (2) ΔRMSEA was ≤0.015 [58]. Convergent and divergent validity was assessed using Pearson's correlation coefficients. The size of the correlations was interpreted using the method described by Cohen [59] wherein *r*-values ≥ 0.10, 0.30, and 0.50 are used as benchmarks for small, medium, and large effects, respectively. A binary logistic regression analysis was performed on the participants in the adult group, with schizophrenia and other psychotic disorders (SZOP), sex, and age in the first block, constituting the dependent variables, and REF factors in the second block, constituting the independent variables. This same analysis was repeated with the youths, whereby the age variable was eliminated (only three participants with SZOP were under 20 years of age). Statistical analyses were performed using Factor 10.4.01, SPSS 24, and Lisrel 8.7 software.

3. Results

3.1. Preliminary analyses

One-way ANOVA of the total REF score between the youth and adult age groups in the general population showed statistically significant differences: $F\ (5,\ 8765) = 267.97$, $p < .001$, $\eta^2 = 0.13$. The *post-hoc* Dunnet's *C*-test showed that the two youth groups had a higher average REF score than the rest of the age groups. A decrease in IRs average with age was observed (Fig. 1; Table S1 in the supplementary material shows an analysis by age). This was fitted to a logarithmic trend of negative tendency and explained almost 76% of the variance ($y = -1.98\ \ln[x] + 10.381$).

One-way ANOVA of the average REF score between the diagnostic categories found significant differences: $F\ (11, 664) = 6.98$, $p < .001$, $\eta^2 = 0.10$ (Table S2 in the supplementary material). The subjects with Schizophrenia and other psychotic disorders (SZOT) had a higher REF average ($M = 12.53$, $SD = 8.44$). The Dunnet's *C*-test showed significant differences between subjects with SZOT and those with depressive disorders ($M = 7.37$, $SD = 6.40$), anxiety ($M = 7.74$, $SD = 6.22$), adjustment disorders ($M = 6.19$, $SD = 5.16$), other disorders applicable to Axis I ($M = 7.64$, $SD = 6.90$), Group C personality disorders ($M = 4.63$, $SD = 4.37$), and unspecified personality disorders ($M = 7.33$, $SD = 4.81$).

3.2. Evidence of validity based on the scale's internal structure

The total sample was divided at random into two groups. The sociodemographic variables (sex and age, $p > .05$), sample (patients, youths and adults healthy) and REF overall measurements ($p > .05$) were equivalent in both groups (Table S4 in the supplementary material).

3.2.1. Exploratory factor analyses

The EFA of the REF scale done with Sample 1 ($n = 4781$) yielded five first-order factors and one second-order factor, explaining 54% of the variance. The EFA was estimated using the "robust diagonally weighted least squares" method on the tetrachoric correlation matrix, with

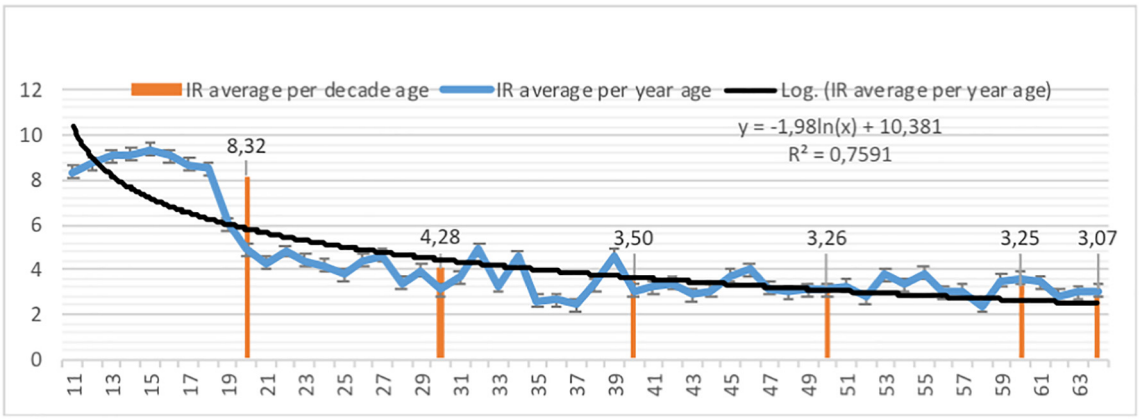

Fig. 1. Average and logarithmic trend of ideas of reference.

promin rotation. Both the Kaiser–Meyer–Olkin test (0.92) and Bartlett's statistic ($X^2_{(561)} = 26{,}470.3$, $p < .001$) indicated that these data had adequate factorability. Schwarz's Bayesian information criterion recommended extraction of five factors that were similar to those found by the authors of the scale, with some differences, as mentioned below.

The first factor corresponds to what the authors call "attention and appearance" and is loaded with Items 8, 9, 18, 21, 24 to 26 and 32, but only the last three items and Item 8 coincide with those found by the authors of the scale. However, the content of the rest of the items fits perfectly with the "attention and appearance" IRs. The second factor concerns "laughing and commenting" and is loaded with items 1 to 4, 6, and 14, all of which corroborate the factor proposed by the scale's authors. The third factor corresponds to "songs, newspapers, and books" and is loaded with items 10 to 13. These items coincide with the original factor by Lenzeweger et al. 1997, however, in the validation by the authors, four additional items loaded which in this EFA saturated on Factor 5. Items 28 to 31 and 33 load on the third factor, which relates to "guilt and shame" IRs. All these items coincide with the factor found by the scale's authors. Items 5, 7, 15, 16, 17, 19, 20, 22, 23, 27, and 34 are grouped together in a fifth factor. This grouping does not correspond to any of the factors found by the authors of the REF scale. The content of these items reflects self-referential interpretations of causality in random or irrelevant events. As such, this factor has been called "causal explanations". Items 16 and 19 have very low communalities (0.175 and 0.070 respectively) and low factor loadings. They can also problematic. Specifically, item 16 refers to driving, which not all respondents do. As such, it is not very discriminative. Similarly, item 19 is the only item on the scale that phrases the question negatively, which may affect the respondents' understanding. Table 2 shows the completely standardized factor loadings.

3.2.2. Reliability

The ordinal α coefficient was estimated for each of the factors in the three samples of participants (see Table 2). All the REF subscales had acceptable indicators in all three samples, although the lowest values were found in the sample of youths, where the α in the "songs, newspapers, and books", not reach 0.70. The ordinal α-value of the total scale across all three samples was 0.97 (patients), 0.94 (youths), 0.97 (adults).

3.2.3. Confirmatory factor analysis

Several CFAs were performed with Sample 2 ($n = 4666$) to test the following models: a null model (Model 1), a unidimensional model (Model 2), the internal structure of the REF scale with in the EFA (Model 3), and the original structure found by Lenzenweger [35] (Model 4). The results of all the CFAs showed excellent fit, but the model with five first-order factors and one second-order factor had the highest goodness-of-fit indicators and the lowest AICs (Table 3).

3.2.4. Measurement invariance across samples and sex

Firstly, individual CFAs were carried out for all cases in each group to find the baseline model, and the goodness-of-fit indicators were found to be adequate. Several multi-group CFAs were then performed on the REF scale across both sex and samples. The unconstrained model (M0) showed adequate fit in both comparisons across samples and across sexes (CFI and RMSEA < 0.05), indicating that the number of underlying factors was equivalent across samples and sex (see Table S5 in the

Table 2
Standardized item-factor loadings for the REF scale with sample 1 (n = 4781).

Variable	Attention, appearance	Laughing, commenting	Songs, newspapers, books	Guilt, shame	Causal explanations
Item 8	**0.871**	0.054	−0.046	−0.006	−0.171
Item 24	**0.741**	0.165	−0.071	0.115	−0.183
Item 25	**0.685**	−0.145	0.134	−0.121	0.108
Item 32	**0.530**	0.003	0.065	−0.103	0.328
Item 21	**0.514**	−0.062	0.009	−0.063	0.249
Item 9	**0.500**	0.302	−0.009	0.101	−0.042
Item 26	**0.477**	−0.121	0.084	0.040	0.214
Item 18	**0.436**	0.219	−0.001	0.032	0.097
Item 3	−0.131	**0.864**	0.083	0.081	−0.116
Item 2	0.141	**0.814**	0.032	−0.155	−0.025
Item 14	0.042	**0.788**	−0.081	0.081	0.043
Item 1	−0.051	**0.743**	0.118	0.103	−0.135
Item 4	0.143	**0.583**	−0.085	−0.022	0.161
Item 6	−0.189	**0.564**	−0.076	−0.018	0.385
Item 10	0.032	−0.030	**0.760**	−0.017	−0.142
Item 11	0.034	−0.060	**0.706**	0.038	−0.137
Item 13	−0.001	−0.055	**0.596**	−0.072	0.217
Item 12	0.111	−0.018	**0.461**	0.060	0.103
Item 31	−0.036	0.074	0.016	**0.757**	0.049
Item 30	−0.115	0.038	−0.042	**0.699**	0.144
Item 28	−0.012	0.011	0.220	**0.531**	−0.019
Item 29	0.021	0.119	0.204	**0.399**	−0.095
Item 33	0.234	0.201	−0.001	**0.344**	0.044
Item 15	−0.239	0.360	0.249	−0.425	**0.887**
Item 17	0.007	−0.128	−0.204	0.197	**0.606**
Item 22	0.146	−0.168	0.070	0.121	**0.569**
Item 5	0.119	0.261	−0.134	−0.024	**0.474**
Item 34	0.297	−0.050	0.082	−0.061	**0.474**
Item 27	−0.034	−0.031	−0.048	0.255	**0.409**
Item 23	0.151	0.364	−0.047	−0.030	**0.402**
Item 20	0.118	−0.014	0.001	0.126	**0.355**
Item 16	−0.038	−0.137	0.059	0.252	**0.262**
Item 7	0.153	0.098	−0.033	0.136	**0.248**
Item 19	0.034	0.152	0.061	−0.118	**0.165**
Ordinal α reliability analysis					
Patients	0.90	0.94	0.87	0.85	0.90
Adults	0.89	0.92	0.81	0.83	0.83
Youths	0.84	0.86	0.69	0.77	0.72

Primary loadings for each observed variable are in bold.

Table 3
Fit indices of confirmatory factor analysis for the four models with sample 2 (n = 4666).

Models[a]	*SB-X*^{2}	*df*	CFI	NNFI	IFI	RMSEA [90% CI]	SRMR	AIC
Model 1	266,370.491	561						266,438.735
Model 2	4121.171	527	0.986	0.986	0.986	0.038 [0.037, 0.039]	0.078	4763.644
Model 3	1914.823	522	0.995	0.994	0.995	0.024 [0.022, 0.025]	0.061	2060.323
Model 4	3092.462	517	0.990	0.989	0.990	0.033 [0.032, 0.034]	0.073	3829.411

[a] Model 1: Null model; Model 2: Unidimensional model; Model 3: The internal structure of the REF scale found in the EFA; Model 4: Original structure of the REF scale obtained by Lenzenweger et al. [35].

supplementary material). Next, the MGCFA was performed to test the factor loading invariant (M1). The comparisons between the M1 and M0 models were not significant (ΔCFI < 0.01 and ΔRMSEA < 0.015), indicating that the factor loading pattern was equivalent across groups and thus that the content of each item was perceived and interpreted in the same way across the samples. Finally, structural invariance was tested (M2). When M2 was compared with M1, no significant increase was observed in the CFI and RMSEA indices, indicating that the dimensionality of the constructs was maintained across groups. These results show that the REF structure, the relationship between the indicators of each variable and their respective latent factor, and the relationship among the latent variables were equivalent across samples and sex.

3.3. Evidence of validity with respect to other scales

In all samples, the total REF score was strongly related to the positive dimension of the CAPE scale, as well as to aberrant salience, indicating convergent validity. Conversely, divergent validity showed low and moderate relationships with public self-consciousness, anxiety, and depression in all three study samples. These results are shown in Table 4, while the correlations are shown with the REF subscales in Table S6 of the supplementary material.

3.4. Evidence of discriminative validity

Binary logistic regression analysis revealed that male sex, age, and high score in "causal explanations", "Songs, newspapers, books" and "laughing and commenting" were clinically useful variables for differentiating patients diagnosed with SZOP from adults with no psychopathology, explaining 40.6% of the variance. In the analysis of the group of youths and the participants diagnosed with SZOP, the percentage of explained variance was somewhat lower (15.6%). All the variables entered were statistically significant. However, as in the analysis of the adults, the "causal explanations" and "laughing and commenting" factors were the best predictors of this diagnostic category (Table 5).

4. Discussion

The main objective of this study was to explore the fit of the REF scale at different ages in the healthy population, as well as in diagnostic categories with patients. IRs, like PLEs in the general population, may provide insight into the onset and maintenance of psychosis. However, the study of PLEs has a drawback because it tends to either under- or overestimate the tendency towards transition to psychosis [15,60]. Nevertheless, its usefulness has also been emphasized [61,62]. Specifically, PLEs span different mental processes that are changeable or unstable until finally becoming delusions [63]. One key to this transition from initial IRs to delusional activity is probably IRs stability, frequency, distress, worry, etc. [42]. However, it should be borne in mind that this study is cross-sectional, and so any allusion to the temporal dimension of IRs must always be tentative and merely made as a proposal.

IRs, like PLEs, are a prodromal indicator or manifestation of different disorders. To illustrate, they have been included among the criteria for body dysmorphic disorder [64]. They are involved in both normal and pathological evolutionary development, but are a major factor in psychotic conditions [6,65].

In the present study, comparisons of IRs as a PLE among age groups showed that youths had the highest scores on the REF scale (large effect size). This result is consistent with the negative relationship between the REF score and age found by Startup, Sakrouge, and Mason [66]. More generally, it corroborates studies involving measures related to paranoia [67] or delusions [68]. In a more detailed analysis of IRs evolution in the present study (Fig. 1 and Table S1 in the supplementary material), the frequency of IRs became stabilized at ages in the twenties. One precedent in the literature showed similar distribution by age and sex, although only one item was related to IRs [69]. This distribution by age may indicate that interpersonal sensitivity develops and adjusts from adolescence to young adulthood [43]. The mean IRs frequency after 21 years of age in the present study corroborated that found in subjects with no psychopathology by the authors of the scale. However, Startup et al. [66] reported an extremely low mean (1.52, *SD* = 1.99). Patients diagnosed with SZOP should have a higher mean than others, although patients with Group A and B personality disorders and bipolar disorder also have higher means (>10 points). However, the difference is too small to draw any definite conclusions.

Nonetheless, when diagnoses are compared to each other or to normal functioning, IRs are generally viewed as static. When IRs evolution is analyzed at different moments in time, change can be observed in such parameters as frequency, conviction, and distress [70], indicating that longitudinal designs must be carried out to verify the stabilization mentioned above, as well as its possible relationship to psychosis onset in specific at-risk populations. As has already been done with other PLEs, such as aberrant salience [44], a follow-up of IRs should be developed using experience sampling or time series. These techniques

Table 4
Pearson's correlations for the REF total and other variables.

	Patient group				
	CAPE Positive (*n* = 33)	Aberrant salience (*n* = 271)	Public self-consciousness (*n* = 190)	GHQ-Anxiety (*n* = 455)	GHQ-Depression (*n* = 455)
REF total	0.656**	0.557**	0.225**	0.125**	0.199**
	Healthy control youth				
	CAPE positive (*n* = 307)	Aberrant salience (*n* = 4788)	Public self-consciousness (*n* = 866)	GHQ- Anxiety (*n* = 726)	GHQ- Depression (*n* = 726)
REF total	0.528**	0.586**	0.342**	0.330**	0.354**
	Healthy control adults				
	Cape positive (*n* = 178)	Aberrant salience (*n* = 775)	Public self-consciousness (*n* = 799)	GHQ- Anxiety (*n* = 1189)	GHQ- Depression (*n* = 1189)
REF total	0.564**	0.460**	0.274**	0.300**	0.289**

** $p < .001$.

Table 5
Results of binary logistic regression analysis of REF total factors associated with presence of the schizophrenia and other psychotic disorders diagnostic class.

Outcome variables	Model	Predictor variables	OR[a]	95% CI	*p*	Nagelkerke's R^2
Healthy control adults vs SZOP[b]	Step 1	Sex	1.09	[2.107, 4.225]	<0.001	0.083
		Age	0.032	[1.021, 1.044]	<0.001	
	Step 2	Sex	2.720	[1.770, 4.179]	<0.001	0.406
		Age	1.172	[1.029, 1.060]	<0.001	
		F1[c]	0.076	[0.949, 1.227]	0.247	
		F2	0.531	[1.481, 1.953]	<0.001	
		F3	0.220	[1.033, 1.503]	0.021	
		F4	0.103	[0.953, 1.290]	0.182	
		F5	0.300	[1.188, 1.532]	<0.001	
Healthy control youth vs SZOP	Step 1	Sex	1.025	[1.988, 3.906]	<0.001	0.029
	Step 2	Sex	1.085	[2.056, 4.257]	<0.001	0.156
		F1	0.174	[0.758, 0.932]	<0.001	
		F2	0.486	[1.458, 1.811]	<0.001	
		F3	0.225	[1.073, 1.463]	0.004	
		F4	0.152	[0.750, 0.984]	0.028	
		F5	0.300	[1.225, 1.487]	<0.001	

[a] OR: odds ratio.
[b] SZOP: Schizophrenia and other psychotic disorders.
[c] F1: Attention, appearance; F2: Laughing, commenting; F3: Songs, newspapers, books; F4: Guilt, shame; F5: Causal explanations.

are a useful precedent for following up IRs in the residual phase of schizophrenia [71].

Concerning the internal structure of the REF scale, the EFA supported five first-order factors and one second-order factor, also recommending the total score of the scale. The structure differs slightly from the one found by Lenzenweger et al. [35] in university students, particularly in the factor known as "causal explanations" in the present study. With only three items, the original subscale (reaction) may have had problems with internal consistency, although the scale's authors did not report on its reliability. Both the overall REF scale and the five first-order factors showed adequate internal consistency, especially in the sample of patients and adults. The analysis of invariance showed that males and females had an equivalent interpretation of the items on the REF scale, as did patients and participants from the general population. No other investigations regarding validation of the REF scale could be found for comparison in the literature, other than the original paper introducing the instrument. Therefore, the present study complements other procedures and samples to forward the understanding of IRs as a mental process related to normal and pathological development.

Compared to other measures, the REF scale showed strong correlation with the positive dimension of the CAPE-42 scale and with aberrant salience, corroborating the results of the scale's authors and of Meyer and Lenzenweger [34] with regards to positive schizotypy and measures of proneness to psychosis ("perceptual aberration" and "magical ideation"). Other studies related to positive symptoms have shown that the relationship of IRs with inner speech is mediated by dissociation [72], as well as by memories of childhood threat and submission [73]. The relationship between IRs and public self-consciousness was low in the group of patients and adults, but moderate in youths. These results suggest, as found by Lenzenweger et al. [35], that referential thinking is a different construct from awareness of the self as a social object. Finally, the correlation between IRs and anxiety and depressive symptoms was low in the group of patients and adults, while it was moderate in the group of youths, corroborating the reports of Lenzenweger et al. [35] and Meyer & Lenzenweger [34].

The regression analyses showed that male sex, in both youths and adults, predicted the SZOP diagnostic category [74]. Among the REF scale factors, the best predictors for comparing adults were "causal explanations", "Songs, newspapers, books" and "laughing and commenting," and all the factors were good predictors in youths. It follows that the different content of the analyzed IRs is significant.

The present study had some limitations. It was a cross-sectional study that used the data sets of several research projects, so many participants did not fill out all the tests. Furthermore, the retest reliability of the current sample is questionable. The section on instruments provides the previous results. However, in the present study, the retest could not be applied to the entire sample. In the patient group, the diversity of the primary diagnoses necessitated grouping by diagnostic category, so the possibility to study IRs within each specific disorder was limited. The diagnoses made by the authors did not follow any structured interviews, and no reliability indicators were set for them; this could limit some of the results. To specify the effect of age on prediction in youths, a larger group of youths with SZOP should have been used. The present study emphasized the importance of the REF scale to differentiate IRs from other PLEs. However, associated factors should also be considered, such as functional decline, distress, deficient coping, and self-disturbance [3,75], although a previous study has investigated concern about IRs [42].

Nonetheless, the present study had some strengths. It was the first to validate the REF since the scale was developed, and it involved a large representative sample of all ages. This enabled the study of IRs from adolescence to old age, providing a scale for their interpretation and comparison (Tables S1 and S3 in the supplementary information), as well as evidence for their invariance across sex, healthy populations, and clinical subjects.

In conclusion, the data provided in the present study suggest that the REF scale could be used to detect IRs with psychometric guarantees, from what is considered normal according to the developmental stage of the subject to what is considered clinically relevant. Future studies should revise the prospective evaluation of this measure, with patient follow-ups and subgroups of at-risk participants. They should also establish the relationship of the REF scale with clinical risk, as determined by diagnostic interview, and with other indicators, such as anxiety, depression, and negative symptoms [76].

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Declaration of Competing Interest

The authors declare that they have no conflicts of interest related to the present study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.comppsych.2019.06.006.

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